329

RESTRICTED CIRCULATION

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An examination of the variation in rainfall with height at a hill station in Lanarkshire

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Introduction

From about Oct. 1957 to December 1969, monthly rainfall totals have been measured at three different sites at the Animal Breeding Research Organisation's Experimental Farm (Stanhope Farm) near Biggar Lanarkshire. The three sites were:

at the standard Agro-meteorological station, 741 ft above msl and designated site "L";

at 1250 ft above msl (Station "M");

at 2500 ft above msl (Station H).

Regular monthly visits, particularly to site H, but at times to site M, during the winter were not always possible and some gaps and uncertainties exist in the data. Although all available data were examined, detailed analysis was confined to those for the years 1957 to 1968.

Description of Sites

The main farm buildings are situated on a north-south valley floor some $\frac{1}{2}$ mile wide (at 55°35'N, 3°26'W; Nat Grid Ref 36/176264) in the upper reaches of the River Tweed on the eastern bank of the valley floor. Eastwards from the valley the ground rises in 2 miles or so to over 2000 ft and thence, within a further one to $1\frac{1}{2}$ miles to a dominantly north-south ridge reaching about 2500 ft with isolated peaks to 2600 ft or so. A similar ridge to the west reaches about 1800 ft within a distance of 2 miles. Site L is situated near the main buildings; site M $2\frac{1}{2}$ miles away at the head of the narrow valley of Stanhope Burn which runs SE to NW and cuts into the main ridge. Site H lies a further $1\frac{1}{2}$ miles to the south east and, at 2500 ft above msl, is well exposed on all directions, being only some 150-200 ft below isolated summits of which Dollar Law (2682 ft above msl) is the nearest.

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To minimise errors from over-exposure, the gauge at site M was situated in a shallow depression whilst that at Site H was placed in a circular hollow some 10 ft in diameter so constructed that the rim of the gauge was roughly at the same level as the surrounding undisturbed rough turf.

Analysis of Data

From a preliminary study of the data it appeared profitable to separate these into two periods viz "winter" - the months of Jan Feb March; Oct Nov Dec

"summer" - the months of April to Sept (inclusive)

In Fig 1 are plotted the annual totals against height; in Fig 2 the rate of increase of annual rainfall with height between Sites L & H (expressed as ins. per 100 ft interval) using as independent variable the annual total at each of the stations in turn. Linear regressions of the increase per 100 ft height interval were computed using each of the three sets of independent variables. In Fig 3 we have the rate of increase with height based as specified above, for the year and for the "winter" and "summer" half-years, against the total (all for same periods).

Clearly Fig 1 there are differences between years both with respect to the slope of the lines and the deviation of M from the straight line joining H & L. In Fig 2 the degree of scatter is least when the rainfall of the highest station is taken as the independent variable and greatest when that for the lowest station is so selected. In other words the best predictor of rate of increase with height is based upon the rainfall at the highest of the three stations with that for the intermediate station taking second place. Obviously in the context of routine extrapolation the result is of limited practical value.

However the actual values of the rate of increase have general interest (Fig 3)

In the eastern parts of the Border hills of Scotland where summer rainfall on the hills ranges from 20 to 40 inches the average rate of increase for the six-monthly total (April-Oct) is about $\frac{1}{2}$" per hundred foot with a rather weak dependence upon height. During the winter half year (rainfall totalling 30 to 60 ins) and for the year as a whole, there are linear increases with height. For the year, for example, if rainfall at heights ranging around 1500-2500 ft is 50 inches, then the increment with height is about one inch for 100 ft rising to 2 inches per 100 ft in a rainfall régime of 80 inches per annum.

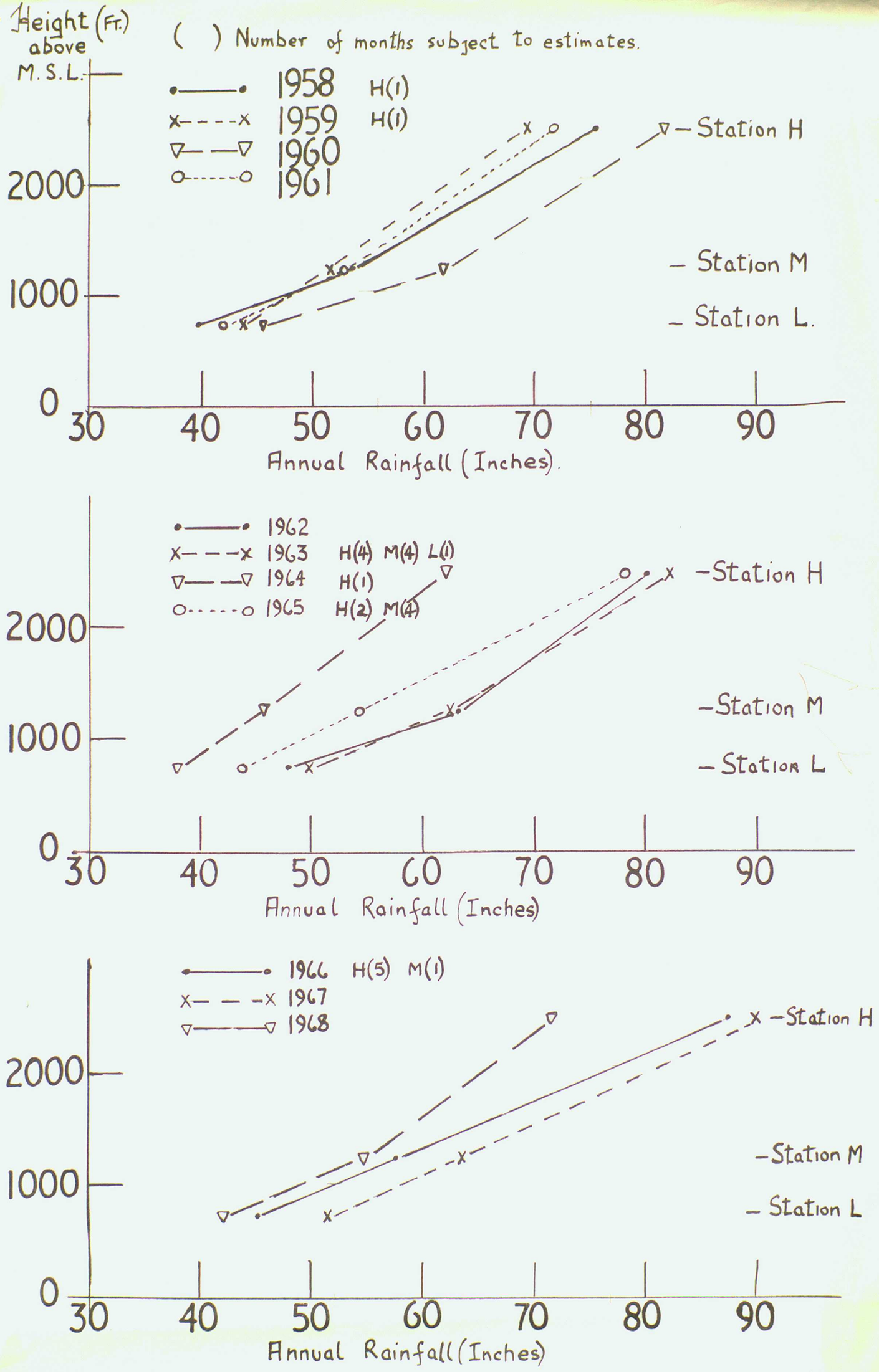

Figure 1. Total annual rainfall at the three stations in individual years

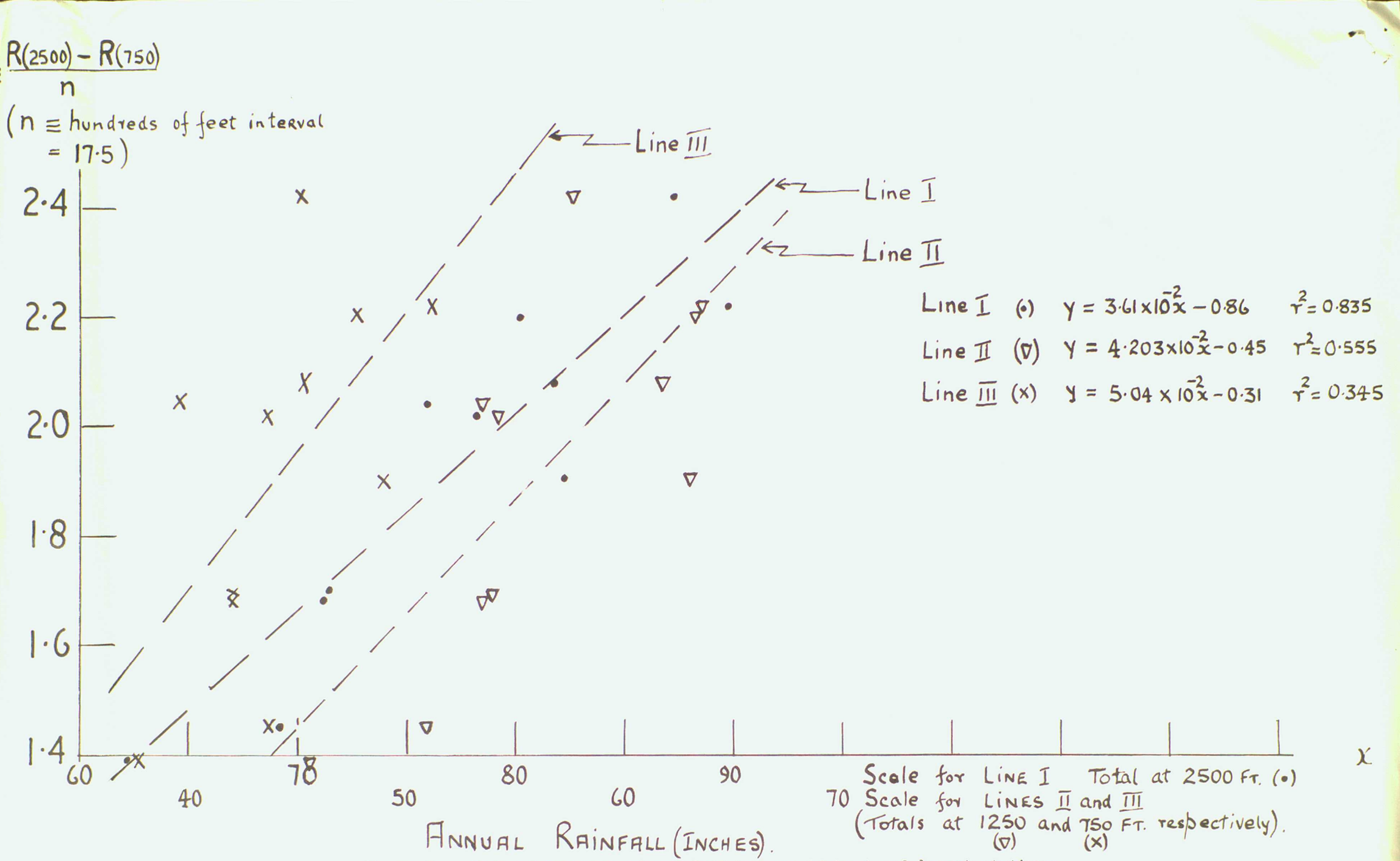

Figure 2. Rate of increase of rainfall between highest and lowest stations (in inches per 100 ft of altitude per annum) against annual rainfall at the three stations separately

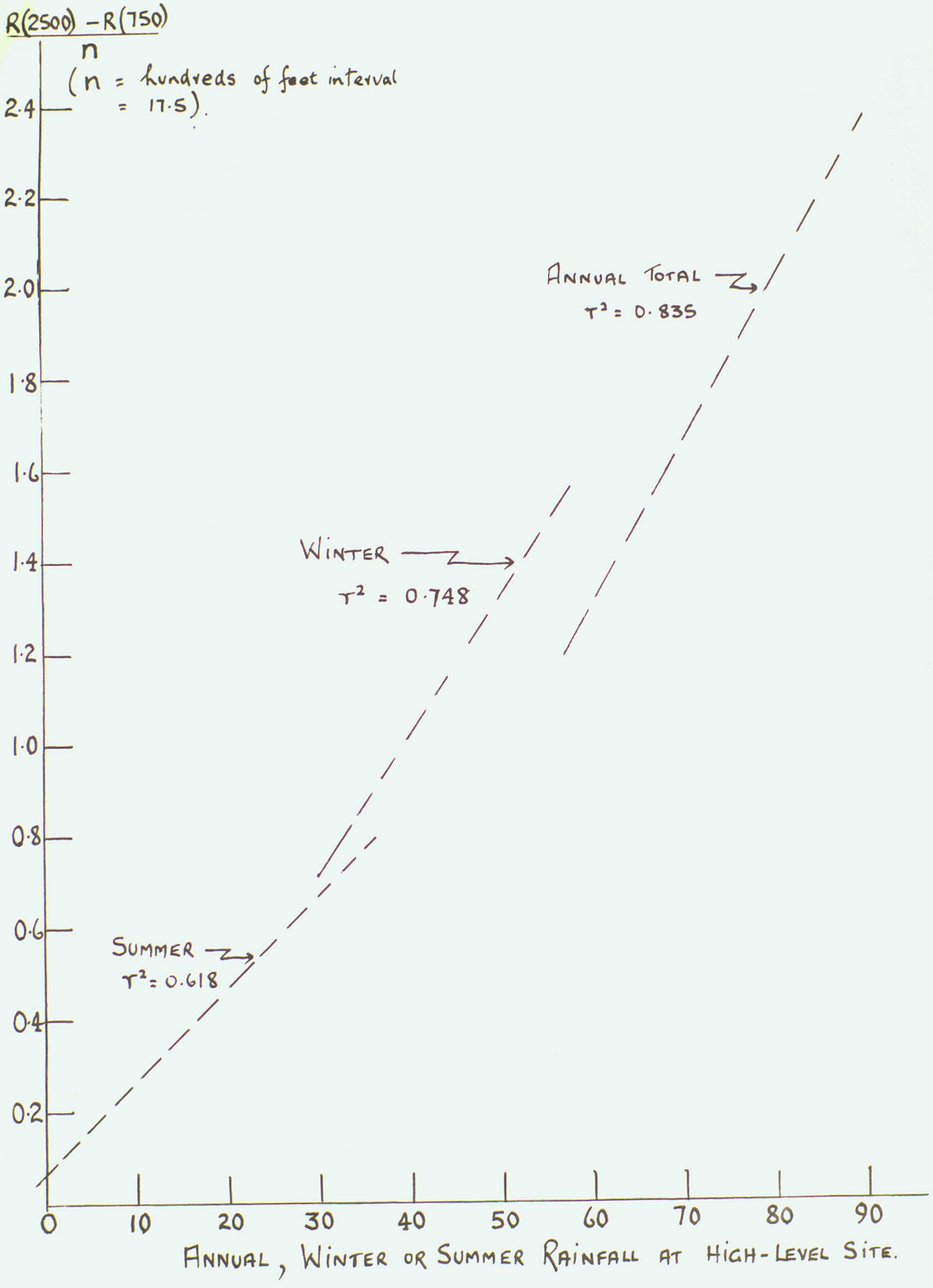

Figure 3. Relationship between increase in rainfall with height (inches per 100 ft per annum) for "winter" and "summer" half-year and annual rainfall as a function of the observed fall at the highest station